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Rosenstand, Claus Andreas Foss; Gertsen, Frank; Tollestrup, Christian H. T.

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## Game-based teaching and examination of radical innovation in corporate entrepreneurship

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Claus A. Foss Rosenstand\*

Aalborg University, Rendsburggade 14, 9000 Aalborg, Denmark.  
E-mail: [cr@hum.aau.dk](mailto:cr@hum.aau.dk)

Frank Gertsen

Aalborg University, Fibigerstraede 10, 9200 Aalborg, Denmark.  
E-mail [fgertsen@business.aau.dk](mailto:fgertsen@business.aau.dk)

Christian Tollestrup

Aalborg University, Rendsburggade 14, 9000 Aalborg, Denmark.  
E-mail [cht@create.aau.dk](mailto:cht@create.aau.dk)

\* Corresponding author

**Abstract:** The area of interest is to use a game-based technique for teaching and examination of students in radical innovation in corporate entrepreneurship. Authors wonder, how they in a short course can give students a closer-to field experience with no or minimum involvement of corporations. The suggestion is the prototype GamExam, simulating the complexity of radicality, uncertainty reduction, and cost of a real life corporate entrepreneurship innovation venture. The prototype is implemented with Microsoft Excel, and is with some success tested out in a class and at an examination; however further research is needed to develop GamExam v. 1.0. The authors have more than five decades of teaching experience in innovation, design, and entrepreneurship; and they are co-developers of a relatively new master program in Entrepreneurial Engineering launched in fall 2013.

**Keywords:** Corporate entrepreneurship; radical innovation; uncertainty reduction; game-based teaching; game mechanics; pedagogy; discovery; incubation; acceleration.

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### 1 Area of interest and research question

The area of interest is to use a game-based technique for teaching and examination of students at the international Entrepreneurial Engineering master program at Aalborg University, Denmark (Aalborg University, 2016). In this program the students earn half of their credits from short courses and the other half from semester-long problem-based projects in diverse teams.

The point of departure is the challenge of how we in a short course can give 1<sup>st</sup> semester students a closer to field experience with radical innovation in corporate entrepreneurship with no or minimum involvement of corporations?

Radical corporate entrepreneurship venture is characterized by being lengthy and by being highly uncertain regarding process, outcome and cost; and hence real-life cases are

not normally an option within short courses in the master program. In order to cope with this the authors has developed the prototype game named GamExam funded by the Danish Foundation for Entrepreneurship (Danish Foundation for Entrepreneurship, 2016). As the name indicates the project also has a purpose of linking closer the teaching with the exam. However, the research question investigated in this paper is:

*How do we simulate the complexity of radicality, uncertainty reduction, and cost of a real life corporate entrepreneurship innovation venture based on a complex game mechanic?*

Together the authors have more than five decades of teaching experience in innovation, design, and entrepreneurship; and they are co-developers of the relatively new master program in Entrepreneurial Engineering launched in fall 2013.

The research problem arises from an experience of a gap between learning outcome of classic curriculum based courses in entrepreneurship and intentions of developing the students' entrepreneurial behavior in project works. This problem is commonly known amongst teachers of innovation management and especially entrepreneurship, often phrased through the question: Can we at all teach entrepreneurship?

This problem has been tackled though learning activities such as workshops and role playing games with relatively simple rules compared to the real-life complexity of radicality, uncertainty reduction, and cost. Therefore simulation based on complex game mechanics might be a new opportunity.

It has been well known for decades that using games to simulate scenarios place the user with a role as a participator (Laurel 1991; Murray 1997; Aarseth 1997; Marie-Laure Ryan 2001). The participator role supports a simulative genre opposed to roles as learner, listener, or spectator respectively supporting a didactic, epic, or dramatic genre (Rosenstand 2005). Moreover it is well argued, that different pedagogical forms can be used by different distributions of control over narrative premise, plot, and structure between user and simulator (Rosenstand 2004). In GamExam there is distributed control over the premise to the user, and the simulator controls the plot and structure. The premise is the morale that the simulator supports, and hence GamExam use a critical pedagogical form, where the user as participator is in a master role, where (s)he has to make moral decisions over what is wrong and right (ibid 2004): Which innovation enablers is it right to select over others according to the radical innovation progress? To this point, this paper is not a general contribution about using simulation as a pedagogical tool; but a specific offer of how GamExam can be used by innovation management teachers; in order to bridge the pedagogical gap between learning outcomes of classic curriculum based courses and intentions with the development of students' entrepreneurial behavior.

## **2 Course and GamExam**

The goal of GamExam in the course is to stage a learning situation, where students are faced with open-ended choices that represent the fuzzy interdependency between numerous variables as in a real setting.

The authors used the first half-year to develop the concept and prototype of GamExam. Students are following a short-course in corporate entrepreneurship, which have been repeated and developed over the last ten years by one of the authors. In this course students are introduced to theories, methods, and techniques primary based on research-based literature on radical innovation complemented by excerpts from articles, textbooks, and tool books from the wide area of innovation management.

The GamExam prototype only covers four innovation phases; 'Research', 'Ideation',

'Validate Product/Service', and 'Validate Business' in order to make an initial proof of concept. After developing the prototype with the complex game-mechanic in a Microsoft Excel-sheet and a faction-based case-scenario, it has been integrated in the short-course, where students in teams have to choose between 56 different innovation enablers in every phase. Each enabler has a cost; and the students only have 20 % of the resources it would take to select all enablers in all four phases. The game mechanic includes cost, radicality and, uncertainty reduction related to each innovation enabler in each phase. This is scored, and the team with the highest product of radicality and uncertainty reduction is the winner of the GamExam.

The score is not correlated with the examination marks; at the oral examination students have to demonstrate reflection on game choices.

As mentioned GamExam is linked to the short-course “Corporate Entrepreneurship” (5 ECTS credits) that focuses on concepts and generic innovation processes in established companies as an outset for business development. Basic concepts and theories of Corporate Entrepreneurship/innovation management are offered. There is an emphasis on high impact innovation, which is also supported by the textbooks being used, latest: “Pivot-how top entrepreneurs adapt and change course to find ultimate success” (Arteaga & Hyland 2014). The book is complemented by various articles and tools.

The progression in the course syllabus follows the general innovation process steps “Discovery”, “Incubation”, and (less of) “Acceleration”. Briefly, the short-course syllabus covers the following themes including indication of the pilot test of GamExam:

1. Introduction (purpose, key concepts)
2. Discovery I (searching for opportunities, tools, Intellectual Property)
3. Discovery II (search areas and approaches, using creativity, tools, case example)
4. Corporate case Novo Nordic (full day case and workshop, building innovation capability, related theory and tool training, by corporate innovation manager)
5. Incubate (principles, means and tools for incubation, Proof of Concept, Proof of Business)
6. Corporate case Sintex (full day case and workshop on incubation, organizing for innovation, tool training, by corporate R&D&E manager)
7. Organizing CE and business models & Introduction to GamExam (a case of organizing corporate entrepreneurship, business modeling, GamExam introduction)
8. Acceleration & GamExam (principle and tools of good practice stage phase, risk, portfolio, diffusion. First round GamExam results and team presentations)
9. Financial projections & GamExam (tools and training in projection of new businesses. Second round GamExam results and team presentations)

Students are presented to a broad palette of innovation enablers (innovation tools and theories, case examples, and training exercises) as part of their short-course curriculum. However it is equally important that students experience and reflect on how different innovation enablers in a corporate entrepreneurship venture are related to “radicality” of innovation, uncertainty reduction, and cost.

GamExam consists of a description of the faction case ‘FEID’ and an excel sheet with choices that the student teams should discuss and score in several rounds related to specific innovation phases taught in the short course.

The case sets the game-universe context. It is a middle size manufacturer and

developer of control units for wind, marine, and land-based power generators. The company is in need of developing new business areas for the future and hires teams of 4-5 students on a project contract basis to come up with whole new concepts.

**Table 1** Extract from GamExam teachers score sheet

<i>Phases:</i>		<b>DISCOVER Y</b>						
<i>Innovation enablers</i>	<i>Cost</i>	<b>Research</b>			<b>Ideation</b>			
		<i>Radicality</i>	<i>Uncer. Reduction</i>	<i>Choice 0/1</i>	<i>Cost</i>	<i>Radicality</i>	<i>Uncer.</i>	<b>Radicality</b>
<b>Brainstorm</b>	<b>10</b>	0,1	0,1	0	0	0	0	0,2
<b>Desktop research</b>	<b>15</b>	0,2	0,1	0	0	0	0	0,1
<b>Identify target market(s) (segments)</b>	<b>20</b>	0,3	0,2	0	0	0	0	1,1
<b>Market penetration analyse</b>	<b>20</b>	0,1	0	0	0	0	0	0,2
<b>Market size analyse</b>	<b>20</b>	0	0	0	0	0	0	0
<b>Competitor analysis</b>	<b>15</b>	0,2	0	0	0	0	0	0,2
<b>Technology scouting</b>	<b>25</b>	0,6	0,4	0	0	0	0	0,3
<b>Field observation</b>	<b>50</b>	0,4	0,6	0	0	0	0	0,4
<b>+ Build Personas</b>	<b>10</b>	0,1	0,1	0	0	0	0	0,1
<b>Focus group interview</b>	<b>20</b>	0,1	0,2	0	0	0	0	0,1
<b>+ Build Personas</b>	<b>10</b>	0,1	0,2	0	0	0	0	0,1
<b>Lead user interview</b>	<b>50</b>	0,8	0,4	0	0	0	0	0,6
<b>+ Build Personas</b>	<b>10</b>	0,1	0,1	0	0	0	0	0,1

Table 1 shows an extract from the GamExam teachers score sheet. The extract shows the first innovation phase ‘Research’ under ‘Discovery’. Column 1 from left shown the optional choices; the list contains 56 tools and methods for all the innovation phases. Column 2 are the costs associated with choosing that option and there is a limited amount of ‘bananas’ that can be spend for all the phases/rounds as well as an indication that the later phases should be expected to be the most expensive ones (in fact, for simplicity the cost of each option is set to be the same in each phase, but the options associate with later phases are the more expensive ones, given that ‘ideas are cheaper than building a production line’). Column 3 is the ‘radicality score’ set by the teachers based on theory, experience and consensus (not visible to the students). Column 4 is the ‘uncertainty score’ set by similar method as the ‘radicality score’. Column 5 is for ‘tick your choices’ and columns 6-8 provide the resulting costs, radicality and uncertainty for summing up the score. The last column on the right shows the next innovation phase (‘Ideation’) and shows that the scores for a particular option changes as students move to a new phase/round of scoring (here the ‘ideation’ phase).

Game mechanics are performative; they make it possible for users (agents) to perform within the normative boundaries of the game rules: "... game mechanics are methods invoked by agents, designed for interaction with the game state" (Sicart 2008). In the case of GamExam the students are the users; and through their interaction with the excel-based game system, they change the state of radicality and uncertainty in the simulated corporation by using the limited resources (cost).

Game mechanics are dependent of game rules; e.g. how much radicality and uncertainty reductions will the enabler "Brain Storm" perform in the discovery phase, and what is the cost? These questions have been asked and answered by the authors for every innovation enabler for all the simulated phases. This is a complex task, because the rules are interdependent and relative; e.g. the cost of one innovation enabler must make sense according to the cost of another innovation enabler. The task is called game balancing, and it cannot be formally calculated; and hence the game mechanic is complex as stated in the research question.

The student teams get a brief introduction to the round during the last part of a lecture. Then they score the sheet before the next lecture and prepare a short presentation arguing about the choices made. An opponent team has been appointed to kick-off a discussion about the choices in class.

Based on the teams' scores the teachers provide a comparison of team scores including announcement of the winner of the round. The scores include 'accumulated radicality', 'accumulated uncertainty reduction' and 'accumulated costs'. The winner will be the team that has managed to achieve the highest radicality yet been able to reduce the uncertainty and keep it within the limited overall budget. This was followed by a discussion in class.

Off course every single rule of GamExam can be discussed; both regarding the single rule and its interdependence to the other rules – respectively regarding game mechanic and game balancing. And this is precisely the pedagogical point of GamExam; because it raises interesting discussions within student teams and in class. And in our experience it provides students with an understanding of real life complexity of a corporate radical innovation venture; on a significantly higher level than we have experienced before.

### *The Exam*

In the pilot run of the GamExam, the exam is organized as an individual oral exam where student draw one out of ten questions and then make a presentation followed by a discussion with the teacher and an internal examiner. Amongst ten questions two were directly related to GamExam. E.g. one question sounded: "Account for the choices and reasoning in the first round (Discovery) of GamExam, including reflections on the results achieved". The exam was a resume of the discussions in class testing the individual student's knowledge.

### *Student feedback*

A feedback session was held after completion of the game. Overall, students appeared to be motivated, thrilled and happy about GamExam as a learning tool. Some discontent mostly related to immature communication and rather weak integration of the case.

Students expressed that it helped them better learn the many available tools and methods (innovation enablers) as well as to understand what and when to use them, including an understanding of the complex interdependence between them. Suggestions for improvements included:

- Convey a better understanding of the assignment
- More distinctive communication of the difference of phases
- A suggestion to feed-back result by using colors instead of numbers
- Improve the case-integration in the game
- Consider introducing some elements of role-play around the game
- Consider to introduce team- individual cases
- Consider using less 'bananas' (limit the amount of resources for buying options)
- Add 'Proof of Market' / 'Go to Market'

### 3 Findings

The data collected is Excel spreadsheets from students plus course and examination evaluation reports.

The research is theoretically underpinned by theory within corporate entrepreneurship, computer games, simulation, design methodology and pedagogy.

The findings of the research in progress shows that it to some extent is possible to simulate the complexity of radicality, uncertainty reduction, and cost of a real life corporate entrepreneurship innovation venture based on complex game mechanics. Thereby communicating transforming researchers implicit knowledge into explicit knowledge.

Students are "forced" to reflect on why innovation enablers are or are not cost effective regarding radicality and uncertainty reduction in a corporate entrepreneurship venture.

The case-scenario has resulted in quite some frustration due to insufficient integration and consistency between the information about the case-scenario and the student's game-situation in the first prototyping cycle. Therefore the authors will look into how this can be improved, including the possibility of integrating GamExam in a role-play game format; where some of the students are playing corporate roles.

### 4 Discussion

According to the current understanding of how we can teach entrepreneurship, the new outcome is a new way of teaching innovation management, where the students gets more experience with and reflection on real life corporate entrepreneurship, than they get with the conventional curriculum teaching.

The combination of interactivity, unpredictability, interdependency and a reflective presentation of choices present students with a situation closer to a real innovation process where every choice has a complex systemic consequence. Even though it is unpredictable, the reflected choice allows students to link theories within innovation and entrepreneurship with concrete enablers that should drive an open-ended development process. This represents a slight shift from purely deductive reasoning of how theories directly should lead to a given choice to a reason also including abduction (Dorst, K. 2011) / problem based reasoning. This indicates use of an experiential learning model (Kolb, 1984) where the active participation and suggestive approach of student is required for the simulation process to move forward, while they reflect on the relevance of different theories.

The rhetoric's of gaming and the competitive aspect serves as a driving and motivational force for the student teams and the link to the exam provides legitimacy of putting intensive effort into the activity.

Because the game balancing of GamExam cannot be formally calculated, it is a normative system; where the authors as experts assess the game rules based on experience and knowledge. This is why GamExam is an expert system; where the use of it has resulted in further game balancing; e.g. the amount of resources for buying innovation enablers are lowered; and minor adjustments in radicality and uncertainty reduction factors are altered. The last game balancing session before introducing GamExam to the students was two of the authors defining a version of the rules with concrete numbers; and testing this on the third author; which resulted in many small changes. Actually uncertainty reduction was not included in the first version of GamExam; only radicality and cost. But one of the first internal tests showed this was too simple to model the reality we tried to simulate. E.g., it is very important to involve and ensure management support to a radical innovation process; because it reduces uncertainty related to implementation; however it is not very important to increasing radicality of the early innovation processes.

The complexity of the game mechanics in GamExam represents the authors' implicit knowledge on a corporate radical innovation venture. By implementing this in a game, where the students have to perform according to this knowledge, we have transformed our some more implicit (tacit) knowledge to explicit knowledge.

The use of GamExam in the context of a corporate entrepreneurship class is a different pedagogic approach than normally used, in the sense that it sets an alternative relation between education and learning. This has of course been new for us as teachers as well as for the students. Therefore we need to focus more on how to communicate the pedagogy more precisely to the students. It is important to communicate very clear, how GamExam is "game balanced", and how it transforms implicit complex knowledge into explicit knowledge.

## **5 Conclusion**

How do we simulate the complexity of radicality, uncertainty reduction, and cost of a real life corporate entrepreneurship innovation venture based on a complex game mechanic? This is the research question unfolded above.

The research in progress shows that the prototype GamExam is a possible answer to this, however further research is needed in order to develop GamExam v. 1.0 – e.g., including acceleration phase and more solid case-scenario integration.

### *Limitations*

Although we have come a way down the road, we realize that the complexity of trying to build teaching activity that mimics the complexity of radical innovation is high. Especially the tacit knowledge and the strength of emotions embedded in real life radical innovation (and experiential learning) are hard to fully embrace in a game.

## **6 Areas for feedback & development**

We look forward to suggestions and ideas for the pedagogical set-up.



Is there anyway to incorporate more hands-on actions into the game, e.g. insert more exercises that create more content of the innovation activities, without prolonging the game and course significantly?

We have discussed the possibility of using GamExam as a business tool; where corporate innovation teams could use the tool to discuss which innovation enablers to include in a radical innovation process; and furthermore to assess the cost of such a process. Would that be possible?

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